Interconnection Requirements

For

Distributed Generation

Sulphur Springs Valley Electric Cooperative

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1. INTRODUCTION

This manual specifies the minimum requirements for safe and effective operation of distributed generation interconnected (or paralleled) with the *Sulphur Springs Valley Electric Cooperative (SSVEC)* radial distribution system. Interconnection requirements as outlined here are for those installations that will be connected to the *SSVEC* distribution system (25 kV or less) and do not backfeed onto the transmission system; installations that backfeed onto the transmission system have additional SSVEC requirements and will also need to comply with all applicable WSCC (Western Systems Coordinating Council), AZ-ISA (Arizona Independent Scheduling Administrator), and NERC (National Electric Reliability Council) requirements, as well as RTO (Regional Transmission Operator) requirements as applicable. Customers and *SSVEC* personnel shall use this document when planning the installation of distributed generation. Note that these requirements may not cover all details in specific cases. The Customer should discuss project plans with *SSVEC* before designing the facility or purchasing and installing equipment. This manual must be applied in conjunction with the following *SSVEC* documents that pertain to the parallel operation of Customer-owned distributed generation with the *SSVEC* electrical distribution system:

- Schedule Q1, Cogeneration & Small Power Producers Single $ Three Phase
- Schedule Q2, Cogeneration & Small Power Producers Single & Three Phase Greater than 100 Kilowatts
- Schedule Q3, Optional Tariff for Supplementary, Standby and Maintenance Power Sales to Qualifying Facilities Exceeding 100 Kilowatts

For the purpose of simplicity, the term "Customer" will be used here to refer to any distributed generator, cogenerator or small power producer, even though they may not actually be purchasers of power from *SSVEC*, and includes any independent party or entity that either invests in, owns or operates a distributed generator or generation facility.

The minimum required protective relaying and/or safety devices and requirements specified in this manual, are for protecting only *SSVEC* facilities and other customer equipment from damage or disruptions caused by a fault, malfunction or improper operation of the distributed generating facility. They are also necessary to ensure the safety of utility workers and the public. Minimum protective relaying and interconnection requirements do not include additional relaying, protective or safety devices as may be required by industry and/or government codes and standards, equipment manufacturer requirements and prudent engineering design and practice to fully protect Customer's generating facility or facilities; those are the sole responsibility of the Customer.

The information contained in this manual contains general information about the interconnection requirements for customer-owned distributed generation. In addition to all applicable regulatory, technical, safety, and electrical requirements and codes, which are not contained in their entirety in this manual, Customers will also be subject to contractual and other legal requirements which are only summarized in this manual. Those regulations, requirements, contracts and other

materials contain complete information concerning interconnection and govern over the general provisions in this manual.

The technical interconnection requirements outlined in this manual shall also apply to any interconnected utility owned or operated distributed generation facility.

SSVEC is committed to making sure that interconnection applications are handled promptly, and to do everything possible to complete the interconnection process in a safe and timely manner. At *SSVEC,* we look forward to working with you to ensure a successful generation project.

2. DEFINITIONS

The following terms, as used in this manual, shall have the meanings specified:

2.1 Interconnect Agreement: An agreement, together with appendices, signed between the utility and the Customer (Generating Facility) covering the terms and conditions governing the interconnection and operation of the Generating Facility with the utility.

2.2 Electric Supply/Purchase Agreement: The Agreement, together with Appendices, signed between *SSVEC, AEPCO,* and the Customer (Generating Facility) covering the terms and conditions under which electrical power is supplied and/or purchased to/from the utility.

2.3 Utility: The electric utility entity that constructs and maintains the distribution system for the delivery of power to the end-user, also referred to as the Utility Distribution Company (UDC).

2.4 Points(s) of Interconnection: The physical location(s) where *SSVEC* service conductors are connected to the Customer's service conductors to allow parallel operation of the Customer's Generating Facility (GF) with *SSVEC's* electric system.

2.5 Distributed Generator: Any type of electrical generator, static inverter or generating facility interconnected with the distribution system that (a) has the capability of being operated in electrical parallel with the *SSVEC* distribution system, or (b) can feed a customer load that can also be fed by the *SSVEC* electrical system. A distributed generator is sometimes referred to simply as "generator" in this manual.

2.6 Generating Facility (GF): All or part of the Customer's electrical generator(s) or inverter(s) together with all protective, safety, and associated equipment necessary to produce electric power at the Customer's facility. A GF also includes any Qualifying Facility (QF).

2.7 Qualifying Facility (QF): Any Cogeneration or Small Power Production Facility that meets the criteria for size, fuel use, efficiency, and ownership as promulgated in 18 CFR, Chapter I, Part 292, Subpart B of the Federal Energy Regulatory Commission's Regulations.

2.8 Cogeneration Facility: Any facility that sequentially produces electricity, steam or forms of useful energy (e.g., heat) from the same fuel source and which are used for industrial, commercial, heating, or cooling purposes.

2.9 Small Power Production Facility: A facility that uses primarily biomass, waste or renewable resources, including wind, solar, and water to produce electric power.

2.10 Minimum Protective Devices, Relays, and Interconnection Requirements: The minimum required protective relaying and/or safety devices or requirements specified in this manual, as may be revised from time to time, are for the purpose of protecting only *SSVEC* and its other customer facilities from damage or disruptions caused by a fault, malfunction or improper operation of the Customer's GF. Minimum Protective Relaying and Interconnection Requirements do not include relaying, protective or safety devices as may be required by industry and/or government codes and standards, equipment manufacturing and prudent engineering design and practice to fully protect the Customer's GF or facilities; those are be the sole responsibility of the Customer.

3. *SULPHUR SPRINGS VALLEY ELECTRIC COOPERATIVE* POLICY ON CUSTOMER-OWNED GENERATION

Any Customer qualified under the Public Utility Regulatory Policies Act (PURPA) of 1978, may operate his generating equipment in parallel with the *SSVEC* radial distribution system provided the Customer provides equipment that will:

(a) not present any hazards to *SSVEC* personnel, other customers or the public,
(b) minimize the possibility of damage to *SSVEC* and other customer equipment,
(c) not adversely affect the quality of service to other customers, and
(d) minimally hamper efforts to restore a feeder to service (specifically when a clearance is required).

In addition, the Customer will also need to comply with the following:

(a) the generating facility meets all the minimum interconnection, safety, and protection requirements outlined in this manual,
(b) Customer signs an Interconnect Agreement, as well as an Electric Supply /Purchase Agreement, as applicable, with *SSVEC*, and Arizona Electric Power Cooperative (AEPCO).
(c) Customer complies with and is subject to all applicable service and rate schedules and requirements, rate tariffs and other applicable requirements as filed with and approved by the Arizona Corporation Commission.

It is the policy of *SSVEC* to also permit customer generating equipment that does not qualify under PURPA to operate in parallel with the *SSVEC* radial distribution system provided that all of the conditions outlined above are complied with. Due to relay coordination and potential backfeed problems, *SSVEC* can not permit any distributed generation to be connected to a network system.

The minimum protective and safety devices (relays, circuit breakers, disconnect switches, etc.) specified in this manual must be installed and placed into service before allowing parallel operation of Customer's generation facilities with the *SSVEC* system. The purpose of these devices is to isolate the Customer's generating equipment from the *SSVEC* system whenever faults or disturbances occur and for maintenance purposes. Modifications to the *SSVEC* electrical system configuration or protective equipment may also be required at the expense of the Customer in order to accommodate parallel generation.

SSVEC will not assume any responsibility for the protection of the Customer's generator(s), or of any other portion of the Customer's electrical equipment. The Customer is fully and solely responsible for protecting his equipment in a manner to prevent any faults or other disturbances from damaging the Customer's equipment.

The Customer must obtain all required permits and inspections indicating that the Customer's generating facility complies with local and other applicable safety codes. *SSVEC* can disallow the interconnection of a Customer's generating facility if, upon review of the Customer's design, it determines that the proposed design is not in compliance with applicable safety codes, or is such that it could constitute a potentially unsafe or hazardous condition.

4. DISTRIBUTED GENERATION TYPES

Distributed generation is any type of generator or generating facility which has the potential (a) for feeding a customer load, where this load can also be fed by, or connected to, the *SSVEC* electrical distribution system, or (b) for electrically paralleling with, or for feeding power back into *SSVEC's* electrical distribution system.

Distributed generators include induction and synchronous electrical generators as well as any type of electrical inverter capable of producing A/C power. A **Separate System, or Emergency or Standby Generation System,** is designed so as to never electrically interconnect or operate in electrical parallel with *SSVEC's* system. A **Parallel System, or Interconnected Generation System,** is as any generator or generation system that can parallel, or has the potential to be paralleled via design or normal operator control, either momentarily or on a continuous basis, with *SSVEC's* system.

The Customer may elect to run his generator as a separate system with non-parallel load transfer between the two independent power systems, or he may run it in parallel with the *SSVEC* system. A description and the basic requirements for these two methods of operation are outlined below.

4.1 Separate System

A separate system is one in which there is no possibility of electrically connecting or operating the Customer's generation in parallel with the utility's system. The Customer's equipment must transfer load between the two power systems in an open transition or non-parallel mode. If the Customer claims a separate system, *SSVEC* may require verification that the transfer scheme meets the non-parallel requirements.

Emergency or Standby generators used to supply part or all of the Customer's load during a utility power outage must be connected to the Customer's wiring through a double throw, "break-before-make" transfer switch specifically designed and installed for that purpose. The transfer switch must be of a visible and fail-safe mechanical throw over design, which will under no circumstances allow the generator to electrically interconnect or parallel with *SSVEC's* system. The transfer switch must always disconnect the Customer's load from *SSVEC's* power system prior to connecting it to the generator. Conversely, the transfer switch must also disconnect the load from the generator prior to re-connecting it back to the *SSVEC* system. These requirements apply to both actual emergency operations as well as to testing the generator. All transfer switches and transfer schemes must be inspected and approved by the jurisdictional electrical inspection agency.

Portable generators are not designed to be connected to a building's permanent wiring system, and are not to be connected to any such wiring unless a permanent and approved transfer switch is used. Failure to use a transfer switch can result in backfeed into the *SSVEC* system – the generator voltage can backfeed through the *SSVEC* transformer and be stepped up to a very high voltage. This can pose a potentially fatal shock hazard to anyone working on the power lines or on utility equipment.

Other than the requirements outlined above in this section, *SSVEC* has no further technical interconnection requirements for a separate system.

4.2 Parallel System

A parallel, or interconnected, generator is connected to a bus common with the utility's system, and a transfer of power between the two systems is a direct result. A consequence of such interconnected operation is that the Customer's generator becomes an integral part of the utility system that must be considered in the electrical protection and operation of the utility system.

Parallel generators encompass any type of distributed generator or generating facility that can electrically parallel with, or potentially backfeed the utility system. Additionally, any generator system using a "closed transition" type transfer switch or a multi-breaker transfer scheme, or an electrical inverter that can be configured or programmed to operate in a "utility interactive mode" constitutes a potential backfeed source to the *SSVEC* system, and are classified as an interconnected generator.

SSVEC has specific interconnection and contractual requirements, as outlined in this manual, that must be complied with, and information that needs to be submitted for all interconnected generators. These include a "visible open" disconnect switch meeting certain requirements to isolate the Customer's system from *SSVEC* system, as well as protective relaying, metering, special rate schedules, and other safety and information requirements. The Customer will be responsible for having the generation system protective schemes tested by a qualified testing/calibration company. *SSVEC* personnel will inspect the system and the Customer will be required to sign an Interconnect Agreement and, as applicable, an Electric Supply/Purchase Agreement with *SSVEC and AEPCO*. *SSVEC* does not extend "blanket approval" to any specific type of generator or generator scheme since each project is site specific and needs to be reviewed on a case-by-case basis.

With respect to the above protection objectives, it is necessary to disconnect the parallel generator when trouble occurs. This is to:

(a) ensure if a fault on the *SSVEC* system persists, the fault current supplied by the Customer's generator is interrupted;
(b) prevent the possibility of reclosing into an out-of-synch isolated system composed of the utility distribution system, or a section thereof, and the Customer's generator; and
(c) prevent reclosing into the Customer's generation system that may be out of synchronization or stalled.

The protection requirements are minimal for smaller installations, but increase as the size of the Customer's generation increases. Small installations usually ensure that the generator is small compared with the magnitude of any load with which it might be isolated. Thus, for any fault on the utility system, utility protective devices will operate

and normally isolate the generation with a large amount of load, causing voltage collapse and automatic shutdown of the generator. For larger installations the probability of isolated operation is higher since the available generation may be sufficient to carry the entire load, or part thereof, of the local *SSVEC* circuit. In instances where the *SSVEC* system arrangement is such that it is possible that the generators will not always be isolated with comparatively large amounts of load, additional protection and generator shutdown schemes are required.

The Customer is solely responsible for the protection of his equipment from automatic reclosing by the utility. *SSVEC* normally applies automatic reclosing to overhead distribution circuits. When the *SSVEC* source breaker trips, the Customer must ensure that his generator is disconnected from the SSVEC circuit prior to automatic reclosure by SSVEC. The automaric reclosing time on the SSVEC distribution system varies from feeder to feeder. Automatic reclosing out-of-synch with the Customer's generator may cause severe damage to Customer equipment and could also pose a serious hazard to Customer or utility personnel.

5. CUSTOMER RESPONSIBILITIES

The Customer is responsible for all facilities required to be installed solely to interconnect the Customer's generation facility to the *SSVEC* system. This includes connection, transformation, switching, protective relaying, metering and safety equipment, including a visibly-open Disconnect Switch and any other requirements as outlined in this manual or other special items specified by *SSVEC*. All such Customer facilities are to be installed by the Customer at the Customer's sole expense. In the event that additional facilities are required to be installed on the *SSVEC* system to accommodate the Customer's generation, *SSVEC* will install such facilities at the Customer's expense. *SSVEC* may also charge the Customer for any administrative costs and/or the costs of studies required to interconnect the Customer's generation.

The Customer will own and be responsible for designing, installing, operating and maintaining:

(a) The generating facility in accordance with the requirements of all applicable electric codes, laws and governmental agencies having jurisdiction.

(b) Control and protective devices, in addition to minimum protective relays and devices, specified in this manual, to protect its facilities from abnormal operating conditions such as, but not limited to, electric overloading, abnormal voltages, and fault currents. Such protective devices must promptly disconnect the generating facility from *SSVEC's* system in the event of a power outage on *SSVEC* system.

(c) Interconnection facilities on the Customer's premises as may be required to deliver power from the Customer's generating facility to the *SSVEC* system at the Point of Interconnection.

The Customer is required to maintain public liability and property damage insurance in amounts not less than ONE MILLION DOLLARS ($1,000,000) per occurrence. Residential customers who do not operate a generating facility comprising rotating machinery rated greater than 50 kW are exempt from this requirement.

All interconnected Customers will be required to sign, in addition to any other purchase, supply or other standby or special agreements as may be applicable, an Interconnect Agreement with *SSVEC*.

Customers that purchase power from, or sell power to, *SSVEC* will be required to sign an Electric Supply/Purchase Agreement with *SSVEC and AEPCO*.

6. MUTUAL UNDERSTANDINGS

6.1 Interconnections

SSVEC will not install or maintain any lines or equipment on a Customer's side of the Point of Interconnection, except it may install its meter and some research equipment. Only authorized *SSVEC* employees (with credentials to identify their company affiliation) may make and energize the service connection between the *SSVEC* system and the Customer's service entrance conductors.

Normally, the interconnection will be arranged to accept only one type of standard service at one Point of Interconnection. If a Customer's generating facility requires a special type of service, or if sales to *AEPCO* will be at a different voltage level, the services will only be provided according to additional specific terms that are outlined in the Electric Supply/Purchase Agreement, applicable rate schedules, or other terms and conditions governing the service.

6.2 Easements and Rights of Way

Where an easement or right of way is required to accommodate the interconnection, the Customer must provide to *SSVEC* suitable easements or rights of way, in *SSVEC's* name, on the premises owned, leased or otherwise controlled by the Customer. If the required easement or right of way is on another's property, the Customer must obtain and provide to *SSVEC* a suitable easement or right of way, in *SSVEC's* name, at Customer's sole cost and in sufficient time to meet the Interconnect Agreement requirements. All easements or rights of way must be on terms and conditions acceptable to *SSVEC*.

6.3 Purchase Rates

The rate applicable to purchases from a Customer's generating facility will depend on the system configuration of the facilities. Because of varied and diverse requirements and operating characteristics associated with any facilities, the generating facility must evaluate and determine which system configuration and attendant purchase rate is most appropriate for it. *SSVEC* will provide information to assist the Customer to assess the available options. The Customer remains fully responsible for such matters, however, and no *SSVEC* assistance or information should be taken as constituting any representation or warranty about any particular option.

Any energy purchases from the Customer's facility will be in accordance with the applicable Electric Supply/Purchase Agreement, any changes required by law or regulation, and such applicable rates authorized by law. Generating facilities with requirements of unusual size or characteristics may require additional or special rate and contract arrangements.

If the purchase of electric energy or capacity would result in greater cost to *AEPCO* than if *AEPCO* generated the energy itself or purchased it from another source, *AEPCO* will not be obligated to buy such energy or capacity from a Customer. When that occurs, *AEPCO* will give reasonable notice to the Customer so that the Customer may discontinue deliveries or elect to sell to *AEPCO* at a lower rate.

6.4 ACC

The rates, terms or other contract provisions governing the electric power sold to a Customer or purchased from the Customer by *AEPCO* are subject to the jurisdiction of the Arizona Corporate Commission. *SSVEC* retains at all times and without restriction the right to file a unilateral ACC application for a change in requirements, charges, classification, or service, or any rule, regulation or agreement as allowed by law.

7. DESIGN CONSIDERATIONS AND DEFINITION OF CLASSES

Protection requirements are influenced by the size and characteristics of the parallel generator along with the nature and operational characteristics of the associated *SSVEC* system. Therefore, similar units connected to different lines could have different protection requirements based on varying load conditions, as well as on utility feeder and transformer characteristics.

7.1 Synchronous Units

Synchronous generators are generally capable of supplying sustained current for faults on the *SSVEC* system. These units can also supply isolated *SSVEC* load providing the load is within the units' output capability.

Reclosing of the utility onto synchronous units must be blocked to prevent out-of-synch paralleling and must also be prevented from energizing a de-energized utility line. Automatic reclosing by *SSVEC* is time-delayed to allow for automatic Customer generator separation prior to utility circuit re-energization.

7.2 Induction Units

Induction generators are basically induction motors that are mechanically driven above synchronous speed to produce electric power. These units do not have a separate excitation system and, as such, require that their output terminals be energized with AC voltage and supplied with reactive power to develop the magnetic flux. Induction generators are therefore normally not capable of supplying sustained fault current into faults on the utility system. Such units are generally not capable of supplying isolated load when separated from the utility system; however, it is possible for an induction generator to become self-excited if a sufficient amount of capacitance exists at its output terminals. Under conditions of self-excitation, an induction generator will be capable of supplying isolated load, providing the load is within the units' output capability. In most cases when self-excitation occurs it will be accompanied by a sudden increase in terminal voltage. *SSVEC* and its other customers must be protected from out-of-phase closing and over-voltages that can occur whenever an induction generator becomes self-excited. Inductions units must therefore be designed to automatically separate from the utility system upon loss of utility voltage and prior to reclosing of the utility feeder.

7.3 Static Inverters

Static inverters convert DC power to AC by means of electronic switching. Switching can be controlled by the AC voltage of the utility's supply system (line-commutated) or by internal electronic circuitry (forced-commutated). Line-commutated inverters are generally not capable of operating independently of the utility's AC supply system and, as such, cannot normally supply fault current or isolated loads. Forced-commutated, or self-commutated, inverters are capable of supplying fault current and load independently of the AC supply system. Any forced-commutated inverter that is to be interconnected with

the utility must be specifically designed for that purpose, i.e. it must be designed to accommodate parallel interfacing and operation.

Reclosing of the utility onto inverter units must be blocked to prevent out-of-synch closing and to prevent the energizing of a de-energized *SSVEC* line.

7.4 Definition of Generator Size Classes

The following generator size classifications are used in determining specific minimum protective requirements for distributed generation facilities. Specified ratings are for each connection to the *SSVEC* system. Customers must satisfy, in addition to the general requirements specified in this manual, the minimum relaying requirements given in this document for each generator class.

(a) Class I -- 50 kW or less, single or three phase
(b) Class II -- 51 kW to 300 kW, three phase
(c) Class III -- 301 kW to 5,000 kW, three phase
(d) Class IV -- over 5,000 kW, three phase

8. INTERCONNECTION TECHNICAL REQUIREMENTS

The requirements and specifications outlined in this section are applicable to all classes of distributed generation, unless otherwise specified. The minimum protection and safety devices and other requirements imposed in the following sections are intended to provide protection for the *SSVEC* system and its other customers. They are not imposed to provide protection for the Customer's generation equipment; this is the sole responsibility of the Customer. These requirements are in addition to requirements outlined in other sections of this manual.

8.1 General Technical Requirements

8.1.1 Customer is responsible for obtaining and maintaining all required permits and inspections indicating that Customer's generating facility complies with local and other applicable construction and safety codes.

8.1.2 Multiple generator connections on the same utility service are permitted subject to *SSVEC* approval; however, a single Disconnect Switch for the facility will be required (normally located at the service entrance section).

8.1.3 A communication channel and telemetering may be required, at the Customer's expense, to facilitate proper parallel operation.

8.1.4 In the event that a generator, or aggregate of generators, are of sufficient size to carry the entire (minimum) load of the utility distribution feeder, or if a generator size and physical location on a feeder is such that it could support an isolated (islanded) section of the feeder, then a transfer trip scheme may be required at the Customer's expense. In certain instances, a dedicated utility feeder may be required.

8.1.5 For synchronous generators, the Customer shall ensure that any potential open points such as breakers, fused disconnect switches, etc, located between the generator breaker and utility service are appropriately equipped with either (1) Kirk key interlocks to prevent them from being inadvertently opened when the generator breaker is closed, or (2) contacts that will instantaneously trip the generator breaker if any such switch were opened while the generator breaker was closed.

This is to prevent the opening and subsequent (inadvertent) re-closing of such a breaker or switch onto an un-synchronized generator.

8.1.6 In the event that the utility is required to install electric meter(s) to record the output of the generator(s), Customer shall ensure that the design is such that the meter(s) are located on the utility-side of the generator breaker on a normally energized bus. Electronic meters are not designed to be de-energized for any length of time.

8.1.7 It should be emphasized that the Customer is responsible for the design, installation, operation and maintenance of all equipment for connection to the *SSVEC* system. It is also the Customer's responsibility to submit specifications and detailed plans as specified in this manual (Appendix A) for the installation to *SSVEC* for review and written approval prior to their purchase and installation. Written approval by *SSVEC* does not indicate acceptance by other authorities.

8.2 Disconnect Switch

The Customer shall install and maintain a visible open, manually- and gang-operated load-break disconnect switch ("Disconnect Switch") capable of being locked in a visibly "open" position by a standard *SSVEC* padlock that will completely isolate the Customer's generating facility from the *SSVEC* system.

The Disconnect Switch blades, jaws and the air-gap between them shall all be clearly visible when the switch is in the "open" position. It is not acceptable to have any of the "visible open" components obscured by the switch case or an arc-shield, etc. Only switches specifically designed to provide a true "visible open" are acceptable. Such Disconnect Switch shall be installed in a place so as to provide easy and unrestricted accessibility to SSVEC personnel on a 24-hour basis. *SSVEC* shall have the right to lock open the Disconnect Switch without notice to the Customer when interconnected operation of the Customer's generating facility with the *SSVEC* system could adversely affect *SSVEC* system or endanger life or property, or upon termination of the Interconnect Agreement.

The Disconnect Switch will normally be required to be installed at the Customer's electrical service entrance section; however it may be located in the immediate vicinity of the generator, subject to *SSVEC* approval.

The Disconnect Switch must be rated for the voltage and current requirements of the generation facility, and must meet all applicable UL, ANSI and IEEE standards. The switch enclosure shall be properly grounded per the requirements of the National Electric Code (NEC).

In cases where the Disconnect Switch will be installed on a line at a voltage above 500V, *SSVEC* has specific grounding requirements that will need to be incorporated into the Disconnect Switch. Under certain circumstances (above 500V, switch located outdoors and underground fed), *SSVEC* may require the customer to install a rack-out breaker, along with a racking tool and grounding breaker, in lieu of a Disconnect Switch. In these cases, *SSVEC* will work with the Customer to determine the best option and ensure that the safety requirements are met.

8.3 Dedicated Transformer

Customer generators with a combined total rating of over 10 kW, as measured at the service entrance, must be isolated from other customers fed off the same utility transformer by a dedicated power transformer connecting to the utility distribution feeder. The purpose of the dedicated transformer is to ensure that the generator cannot become isolated at the secondary voltage level with a small amount of other-customer load. It also helps to confine any voltage fluctuation or harmonics produced by the generator to the Customer's own system. *SSVEC* will specify the transformer winding connections and any grounding requirements.

8.4 Power Quality

In order to minimize interference on the utility system the Customer should ensure that the electrical characteristics of it's load and generating equipment meet, as a minimum, the specifications promulgated in the Institute of Electrical and Electronic Engineers (IEEE) Standard 519-1992.

8.4.1 **Power Factor**

The power factor of the Customer's facility shall not be less that ninety percent (90%) lagging, but shall not be leading, unless agreed to by *SSVEC*.

8.4.2 **Current Imbalance**

The current imbalance for a three-phase system as measured at the Customer's service entrance section shall not be greater than ten percent (10%) at any time.

8.4.3 **Harmonics**

The electrical output of the Customer's generating facility shall not contain harmonic content which may cause disturbances on or damage to *SSVEC* electrical system, or other customer's systems, such as but not limited to computer, telephone, communication and other sensitive electronic or control systems.

8.4.4 **Power Fluctuations**

The Customer must exercise reasonable care to assure that the electrical characteristics of its load and generating equipment, such as deviation from sine wave form or unusual short interval fluctuations in power demand or production, shall not be such as to result in impairment of service to other customers or in interference with operation of computer, telephone, television or other communication systems or facilities.

8.4.5 **Voltage Flicker**

If Customer utilizes the *SSVEC* system to facilitate start-up of its generating facility, the voltage flicker level shall not exceed *SSVEC* standards.

8.5 Voltage Requirements

Customer generating equipment must deliver at the Point of Interconnection, 60 Hertz, either single or three-phase power at one standard voltage. (normally 24,940; 12,470; 277/480; 120/240; or 120/208 volts as may be selected by the Customer subject to availability at the premises). Interconnections at other voltage levels will be handled on a case-by-case basis.

8.6 Labeling Requirements

8.6.1 **Disconnect Switch**

The Customer shall label the Disconnect Switch "Interconnected Utility Disconnect Switch" (or "Photovoltaic Inverter, Wind Turbine, etc, Utility Disconnect Switch", as the case may be) by means of a permanently attached placard with clearly visible and permanent letters**.**

8.6.2 **Breaker Panels**

The Customer is responsible for ensuring that all electrical devices such as panel boxes, etc., which are or can be back-fed by the Customer's generator(s) are clearly identified/labeled as such in accordance with the requirements of the National Electrical Code. *SSVEC* will assume responsibility for labeling any utility equipment.

8.7 Protective Relaying Requirements

8.7.1 **General Requirements**

8.7.1.1 The Customer shall be solely responsible for properly protecting and synchronizing his generator(s) with the *SSVEC* system.

8.7.1.2 Customer facility shall include a UL approved automatic interrupting device that is rated to interrupt available fault (short circuit) current. The interrupting device shall be tripped, as a minimum, by all protective devices required herein.

8.7.1.3 Inherent characteristics of induction disk type voltage and frequency relays render their use unsuitable for some generator interface protection applications. Therefore, relays with definite level and timing

characteristics (e.g., solid state type relays) will be necessary to meet the minimum requirements established herein.

8.7.1.4 For generator classes II and above (>50 kW) that require both voltage and frequency relay protection, separate and independent voltage and frequency relays and associated trip paths to the generator breaker (automatic interrupting device) are required. This is to ensure a redundant trip function in the event of a single relay failure or out-of-tolerance condition. It is acceptable however, for the over/under voltage functions to be integrated into a single o/u voltage relay, and for the over/under frequency functions to be integral to a single o/u frequency relay.

8.7.1.5 The generator protective scheme shall be of a fail-safe design such that loss of the protection scheme control power will immediately cause the generator breaker to open.

8.7.2 Minimum Relaying Requirements

8.7.2.1 Class I (Single or Three Phase: 50 kW or less)

1. The minimum protection required is an under-voltage contactor.

2. For all synchronous generators and forced commutated inverters, a synchronizing scheme, either manual with synch check relay, or an automatic synchronizer is required.

8.7.2.2 Class II (Three Phase: 51-300 kW)

1. Relays for overvoltage, undervoltage, overfrequency, and underfrequency are required.

2. For all synchronous generators and forced commutated inverters, a synchronizing scheme, either manual with synch check relay, or an automatic synchronizer is required.

3. For installations interconnected to the utility through a transformer with connections that will not supply current to a ground fault on the utility system, a ground fault detector may be necessary. The utility will advise Customer of any such requirements after a preliminary review of the Customer's proposed installation.

8.7.2.3 **Class III (Three Phase: 301-5,000 kW)**

1. For this class of installation, utility grade protection devices and equipment will be required.

2. Relays for overvoltage, undervoltage, overfrequency, and underfrequency are required.

3. For all synchronous generators and forced commutated inverters, a synchronizing scheme, either manual with synch check relay, or an automatic synchronizer is required.

4. For installations interconnected to the utility through a transformer with connections that will not supply current to a ground fault on the utility system, a ground fault detector may be necessary. The utility will advise Customer of any such requirements after a preliminary review of the Customer's proposed installation.

5. Other equipment such as supervisory control and alarms, telemetering, and associated communications channel may be necessary. The utility will advise Customer of any communications requirements after a preliminary review of the proposed installation.

8.7.2.4 **Class IV (Three Phase: Greater than 5,000 kW)**

Note: Induction Generators or Line Commutated Inverters (LCI) in this size range are not anticipated.

1. For this class of installation, utility-grade protective devices and equipment will be required.

2. Relays for overvoltage, undervoltage, overfrequency, and underfrequency are required.

3. For all synchronous generators and forced commutated inverters, a synchronizing scheme, either manual with synch check relay, or an automatic synchronizer is required.

4. A ground time overcurrent and instantaneous overcurrent relay, or for installations interconnected to the utility through a transformer with connections that will not supply current to a ground fault on the utility system, a ground fault detection scheme is required.

5. The following relays are also required:
   (a) Voltage-controlled time overcurrent relays, one per phase
   (b) Negative sequence time overcurrent relay
   (c) Overexcitation relay
   (d) Loss of excitation relay

6. Other equipment such as supervisory control and alarms, telemetering, and associated communications channel may be necessary. The utility will advise Customer of any communications requirement after a preliminary review of the proposed installation.

The minimum protective relaying requirements for parallel operation of distributed generation are summarized in the following table:

Summary of Minimum Protective Relaying Requirements

	Induction Generator/ Line Commutated Inverter	Synchronous Generator/ Forced Commutated Inverter
Class I 50 kW or less	Undervoltage contactor	Undervoltage contactor Synchronizing
Class II 51 to 300 kW	Overvoltage, Undervoltage Overfrequency, Underfrequency	Overvoltage, Undervoltage Overfrequency, Underfrequency Synchronizing
Class III 301 to 5,000 kW	Overvoltage, Undervoltage Overfrequency, Underfrequency	Overvoltage, Undervoltage Overfrequency, Underfrequency Synchronizing
Class IV Greater than 5,000 kW	No induction generators of this size anticipated	Overvoltage, Undervoltage Overfrequency, Underfrequency Synchronizing Ground Time Overcurrent Ground Instantaneous Overcurrent Voltage-controlled Time Overcurrent Loss of Excitation Overexcitation Negative Sequence Time Overcurrent

8.7.3 **Relay Settings**

Voltage and frequency relays needed for minimum interface protection for all classes will have setting limits as specified below.

8.7.3.1 Undervoltage relays will operate at no less than 88% of the nominal voltage level (106 volts on a 120V base) and will have a maximum time delay of 1.0 seconds.

8.7.3.2 Overvoltage relays will operate at no greater than 110% of nominal voltage (132 volts on a 120V base) and will have a maximum time delay of 1.0 seconds.

8.7.3.3 Overfrequency relays will operate at no greater than 60.5 Hz and will have a maximum time delay of 0.1 seconds.

8.7.3.4 Underfrequency relays will operate at no less than 59.3 Hz and have a maximum time delay of 0.1 seconds.

Additional settings for Class IV installations and/or any other relays that may be required due to unusual circumstances will be handled on an individual basis.

9. METERING REQUIREMENTS

The requirements of this section are applicable to Customers that Interconnect to the SSVEC system.

The Customer must provide and install at Customer's expense, and in accordance with *SSVEC* service standards, meter sockets and metering cabinets in a suitable location.

SSVEC will furnish, own, install and maintain all meters that register the sales of power to, and the purchase of energy from the Customer. The responsibility for the costs of providing and maintaining the required meters will be outlined in the applicable rate tariff, or specified in the Electric Supply/ Purchase Agreement.

10. APPLICATION PROCESS AND DOCUMENTATION REQUIREMENTS

Note: *SSVEC* approvals given pursuant to the review and approval process and the Interconnection Agreement shall not be construed as any warranty of representation to Customer or any third party regarding the safety, durability, reliability, performance or fitness of Customer's generation and service facilities, its control or protective device or the design, construction, installation or operation thereof.

10.1 The Customer must submit written equipment specifications and plans for the installation and operation of it's generating facilities, interconnection facilities, control and protective devices and facilities for *SSVEC* review and advance approval prior to actual equipment installation. The "Application and Equipment Information Form" attached to this document as Appendix A must be completed and all supplementary information requested therein must be provided.

SSVEC strongly encourages each Customer to contact and work closely with *SSVEC* at the conceptual stages of the design to ensure that the project proceeds smoothly. *SSVEC* will generally require a single point of contact with which to coordinate the interconnection process.

10.2 In the event it is necessary for *SSVEC* to install interconnection facilities on its system (including but not limited to control or protective devices, or any other facilities), in order to accommodate or protect the Customer's generation facility or *SSVEC* equipment, *SSVEC* will inform the Customer of the cost and the Customer must reimburse *SSVEC* for the costs incurred by *SSVEC* to the extent they exceed those normally incurred by *SSVEC* for customers who do not have self generation facilities.

10.3 Following *SSVEC* approval of the Customer's proposed generating facility and associated facilities, the Customer cannot remove, alter or otherwise modify or change the equipment specifications, including, without limitation, the plans, control and protective devices or settings, and in general the generating facility system configuration or any facilities appurtenant thereto. If the Customer desires to make such changes or modifications, the Customer must resubmit to *SSVEC* plans describing the changes or modifications for approval by *SSVEC.* No change or modification may be made without the prior written approval of *SSVEC.*

11. TESTING AND START-UP REQUIREMENTS

11.1 Following *SSVEC* approval of the Customer's generating facility and associated minimum interconnection requirements, the Customer shall, at a minimum, have all specified interface equipment, shutdown and associated protective devices tested and calibrated at the time of installation by qualified personnel and shall also perform functional trip testing of these relays and associated generator or inverter breaker. Calibration must include on-site bench testing of pickup and timing characteristics of the relays. Functional testing must demonstrate that each (minimum) protective relay trip function as required herein, upon a (simulated) out of tolerance input signal will trip the generator breaker, and shall also include a simulated loss of control power to demonstrate that the generator breaker will open. A trip timing test (simulated loss of voltage) will suffice for static inverters rated 50kW or less.

11.2 The Customer shall provide *SSVEC* with a copy of calibration and functional test results. Customer must also notify *SSVEC* at least five (5) working days in advance that such tests are to be performed and allow *SSVEC* personnel to witness such tests.

11.3 The Customer will be required to have a signed Interconnect Agreement with *SSVEC*, and will need to provide *SSVEC* with a copy of the insurance certificate, as applicable, prior to electrically paralleling the generating facility with the *SSVEC* system.

11.4 The Customer will not commence interconnected operation of its generating facility until the installation has been inspected by an authorized *SSVEC* representative and final written approval is received from SSVEC to commence interconnected operation, which approval shall not be unreasonably withheld. The Customer shall give *SSVEC* at least five (5) working days prior to notice of when initial startup is to begin. *SSVEC* will have the right to have a representative present during initial energizing and testing of the Customer's system.

11.5 The Customer shall have all protective devices tested by a competent testing firm at the time of installation, prior to initial interconnection, and at intervals not to exceed four (4) years by qualified test personnel. The Customer shall (i) notify *SSVEC* as to when such tests are to be performed at least five (5) working days prior to such tests and allow *SSVEC* personnel to witness the test, and (ii) provide *SSVEC* with a certified copy of the test results.

12. OPERATIONAL AND MAINTENANCE REQUIREMENTS

12.1 The Customer will be responsible for operating and maintaining the generator facility in accordance with the requirements of all applicable safety and electrical codes, laws and governmental agencies having jurisdiction.

12.2 The Customer shall protect, operate and maintain the generating facility in accordance with those practices and methods, as they are changed from time-to-time, that are commonly used in prudent engineering and electric utility operations and shall operate and maintain the generating facility lawfully in a safe manner and non-hazardous condition.

12.3 The Customer will allow *SSVEC* and its authorized agents access to the protective relaying and control facilities to conduct whatever startup or periodic tests *SSVEC* deems necessary. *SSVEC* will provide the Customer with advance notice of such tests, so that the Customer's representatives may be in attendance when such tests are performed.

12.4 In the event *SSVEC* or its authorized agents lock open the Disconnect Switch, the Customer shall not remove or tamper with such lock.

12.5 *SSVEC* will be allowed to install on Customer's premises any instrumentation equipment for research purposes. Such equipment shall be owned, furnished, installed and maintained by *SSVEC*.

12.6 *SSVEC* (including its employees, agents and representatives) shall have the right to enter the Customer's premises to (a) inspect the Customer's generating facility, protective devices, and to read or test instrumentation equipment that *SSVEC* may install, provided that as reasonably as possible, notice is given to the Customer prior to entering its premises; (b) maintain or repair *SSVEC* equipment; (c) disconnect the generating facility without notice if, in *SSVEC's* opinion, a hazardous condition exists and such immediate action is necessary to protect persons, SSVEC facilities or other customers' or third parties' property and facilities from damage or interference caused by the Customer's generating facility, or improperly operating protective devices; (d) open the Disconnect Switch without notice if an operating clearance is required by *SSVEC* personnel; (e) close the Disconnect Switch upon completion of *SSVEC* work performed under an operating clearance.

12.7 Upon termination of the Interconnect Agreement, the Customer shall be responsible for ensuring that the Disconnect Switch is immediately opened, and that the electric conductors connecting the Customer's generator(s) to the Disconnect Switch are lifted and permanently removed, so as to preclude any possibility of interconnected operation in the future. *SSVEC* reserves the right to inspect the Customer's facility to verify that the generator is permanently disconnected.

APPENDIX A

APPLICATION AND EQUIPMENT INFORMATION FORM

Return completed form and required supplementary information to:

Sulphur Springs Valley Electric Cooperative
Attn: Michael Masters
Engineer Technician II
P.O. Box 820
Willcox, AZ 85644

Tel: (520) 384-5463

APPENDIX A

APPLICATION AND EQUIPMENT INFORMATION FORM

SITE AND CUSTOMER INFORMATION
(Complete all items)

Company Name (if applicable)_____

Generating Facility Address _____

Mailing Address_____

Customer Contact_____ Telephone_____

SSVEC Account Number _____ *SSVEC* Meter No. _____

Completed By _____Telephone_____

PROPOSED OPERATION
(Answer all questions)

A. Is the Generation Facility a Qualifying Facility (QF) as defined in the Definitions section of the document? (Yes or No) _____.

B. Does the Generation Facility plan on selling excess power generated back to the utility? (Yes or No)_____.

C. Does the Generation Facility plan on being a net exporter of energy into the utility grid? (Yes or No)_____. If "Yes", explain the proposed operation and estimated power to be exported:

_____

_____

_____

_____

D. If the Generating Facility will be used only to displace utility power, will it be operated as a peak-shaving or base-loaded unit?

_____

_____

_____

E. Provide the anticipated project startup date:_____

GENERATOR INFORMATION

(Complete for rotating generators only)

A. Manufacturer _____

B. Type (Synchronous, Induction, D.C.) _____

C. Nameplate rating
Voltage _____ kW _____
Power Factor _____ Frequency _____
Model No._____ Single or Three Phase_____

D. Type of Excitation System (Self or Separate)_____

E. Generator Electrical Characteristics (on the machine base, for Class 2 and above)

Synchronous Reactance (Xd) _____
Transient Reactance (X'd) _____
Subtransient Reactance (X"d) _____
Zero sequence reactance (XO) _____
Negative sequence reactance (X2) _____

F. Number of Units _____

PRIME MOVER

(Complete for rotating machinery only)

A. Manufacturer _____
B. Manufacturer's Reference Number _____
C. Energy Source (Natural Gas, Steam, etc.) _____

INTERFACE EQUIPMENT

(Complete for rotating generators only)

A. Synchronizer for Synchronous Generator:
Manufacturer _____
Manufacturer's Reference Number _____
Automatic or Manual Synchronizer _____

B. Inverter for DC generator:
Manufacturer _____
Manufacturer's Reference Number _____
Line or Self Commutated Inverter _____
No. of Units _____

STATIC INVERTER
(Complete for DC to AC Inverters only)

A. Manufacturer _____ Model No. _____
B. Terminal Voltage _____ Single, Split or Three Phase _____
C. Nameplate kW _____ No. of Units _____
D. Frequency _____ Power Factor _____
E. Line or Self Commutated _____
F. Total System kW Output _____
G. Energy or Fuel Source_____

PROTECTION EQUIPMENT
(Complete all applicable items, attach a separate sheet if necessary)

A. Manufacturer's Name for each Protective Device _____
_____
_____

B. Manufacturer's Reference Number for each Protective Device
_____
_____

C. Range of Available Settings for each Protective Device _____
_____
_____

D. Proposed Settings (trip setpoint and time) for each Protective Device
_____
_____

E. Ratios of associated current transformer. If multi-ratio, state the available ratios and which ratio will be used
_____
_____

F. Describe operation for tripping of the interface or generator circuit breaker for both

1. Utility voltage outage_____
_____
_____

2. Utility short circuit (three phase and single phase to ground)
_____
_____

SUPPLEMENTARY INFORMATION

(Information below to be submitted for all projects. All diagrams are to be professionally and neatly drawn. Generally, free hand drawn and illegible diagrams will not be accepted by *SSVEC*..

A. Electrical One-Line Diagram:

Provide 4 sets, including any and all revisions or changes as they are made. Diagram(s) must also include project name and address, show generator size and all protective relaying and control equipment, as well as electric service entrance and utility meter.

B. Electrical Three-Line Diagram:

Provide 4 sets, including any and all revisions or changes as they are made. Diagram(s) must also include project name and address, show generator size and all protective relaying and control equipment, as well as electric service entrance and utility meter, and include all neutral and ground conductors and connections.

C. AC & DC Control Schematics:

Provide 4 sets, including any and all revisions or changes as they are made, for all projects comprising rotating machinery. Diagrams must show the detailed wiring of all protective relays and control functions, and include control power source and wiring.

D. Detailed Map:

Provide 4 sets of detailed maps, including any and all revisions or changes as they are made. Maps should show major cross streets and proposed plant location, and include the street address.

E. Site Plan:

Provide 4 sets of site plans, including any and all revisions as they are made, showing the arrangement of the major equipment, including the electric service entrance section and utility meter, location of generator and interface equipment, and location of the Disconnect Switch. Include the street address, and location of the any lock-boxes, etc.

F. Testing Company:

Provide the name of the company that will do the protective relay bench testing and the trip circuit functional tests and the anticipated start up date.

G. Point of Contact

If the interconnection and start-up process is to be coordinated through a party or individual other than the Customer, provide the name, company, address and phone number of that individual or party with whom the utility is to coordinate the interconnection.